Artificial Intelligence in Advanced Manufacturing: Current Status and Future Outlook

Abstract

Today's manufacturing systems are becoming increasingly complex, dynamic, and connected. The factory operations face challenges of highly nonlinear and stochastic activity due to the countless uncertainties and interdependencies that exist. Recent developments in artificial intelligence (AI), especially Machine Learning (ML) have shown great potential to transform the manufacturing domain through advanced analytics tools for processing the vast amounts of manufacturing data generated, known as Big Data. The focus of this paper is threefold: (1) review the state-of-the-art applications of AI to representative manufacturing problems, (2) provide a systematic view for analyzing data and process dependencies at multiple levels that AI must comprehend, and (3) identify challenges and opportunities to not only further leverage AI for manufacturing, but also influence the future development of AI to better meet the needs of manufacturing. To satisfy these objectives, the paper adopts the hierarchical organization widely practiced in manufacturing plants in examining the interdependencies from the overall system level to the more detailed granular level of incoming material process streams. In doing so, the paper considers a wide range of topics from throughput and quality, supervisory control in human–robotic collaboration, process monitoring, diagnosis, and prognosis, finally to advances in materials engineering to achieve desired material property in process modeling and control.